PB-240 509

TRACE LAKE, TODD COUNTY, MINNESOTA

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
Minnesota Pollution Control Agency
Minnesota National Guard

November 1974

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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I

REPORT
ON
TRACE LAKE
TODD COUNTY
MINNESOTA
EPA REGION V
WORKING PAPER No. 130

WITH THE COOPERATION OF THE
MINNESOTA POLLUTION CONTROL AGENCY
AND THE
MINNESOTA NATIONAL GUARD
NOVEMBER, 1974

II

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Minnesota Pollution Control Agency for professional involvement and to the Minnesota National Guard for conducting the tributary sampling phase of the Survey.

Grant J. Merritt, Director of the Minnesota Pollution Control Agency, John F. McGuire, Chief, and Joel G. Schilling, Biologist, of the Section of Surface and Groundwater, Division of Water Quality, provided invaluable lake documentation and counsel during the course of the Survey; and the staff of the Section of Municipal Works, Division of Water Quality, were most helpful in identifying point sources and soliciting municipal participation in the Survey.

Major General Chester J. Moeglein, the Adjutant General of Minnesota, and Project Officer Major Adrian Beltrand, who directed the volunteer efforts of the Minnesota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

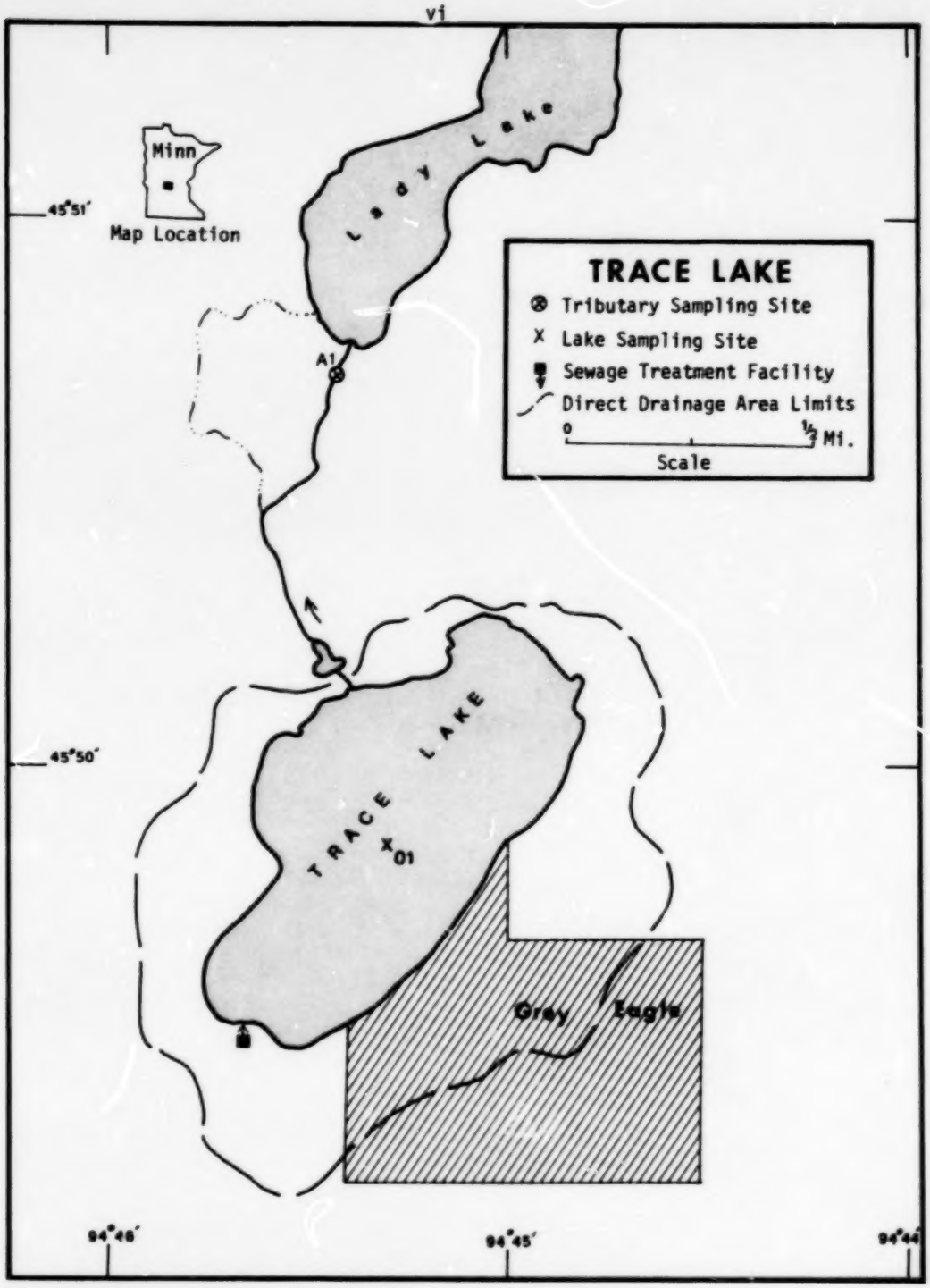
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MINNESOTA

LAKE NAME	COUNTY
Albert Lea	Freeborn
Andrusia	Beltrami
Badger	Polk
Bartlett	Koochiching
Bear	Freeborn
Bemidji	Beltrami
Big	Stearns
Big Stone	Big Stone, MN; Roberts, Grant, SD
Birch	Cass
Blackduck	Beltrami
Blackhoof	Crow Wing
Budd	Martin
Buffalo	Wright
Calhoun	Hennepin
Carlos	Douglas
Carrigan	Wright
Cass	Beltrami, Cass
Clearwater	Wright, Stearns
Cokato	Wright
Cranberry	Crow Wing
Darling	Douglas
Elbow	St. Louis
Embarass	St. Louis
Fall	Lake
Forest	Washington
Green	Kandiyohi
Gull	Cass
Heron	Jackson
Leech	Cass
Le Homme Dieu	Douglas
Lily	Blue Earth
Little	Grant
Lost	St. Louis

LAKE NAME	COUNTY
Madison	Blue Earth
Malmedal	Pope
Mashkenode	St. Louis
McQuade	St. Louis
Minnetonka	Hennepin
Minnewaska	Pope
Mud	Itasca
Nest	Kandiyohi
Pelican	St. Louis
Pepin	Goodhue, Wabasha, MN; Pierce, Pepin, WI
Rabbit	Crow Wing
Sakatah	Le Sueur
Shagawa	St. Louis
Silver	McLeod
Six Mile	St. Louis
Spring	Washington, Dakota
St. Croix	Washington, MN; St. Croix, Pierce, WI
St. Louis Bay	St. Louis, MN; Douglas, WI
Superior Bay	St. Louis, MN; Douglas, WI
Swan	Itasca
Trace	Todd
Trout	Itasca
Wagonga	Kandiyohi
Wallmark	Chisago
White Bear	Washington
Winona	Douglas
Wolf	Beltrami, Hubbard
Woodcock	Kandiyohi
Zumbro	Olmstead, Wabasha


Minn
Map Location
45°51'
Lady Lake
TRACE LAKE
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Direct Drainage Area Limits
0
½ Mi.
Scale
A1
45°50'
TRACE LAKE
X01
Gray Eagle
94°46'
94°45'
94°44'

TRACE LAKE

STORET NO. 2792

I. CONCLUSIONS

A. Trophic Condition:

Survey data show that Trace Lake is eutrophic. Among the 60 Minnesota lakes sampled in the fall when essentially all were well-mixed, only five had more mean total phosphorus, and only 10 had more mean inorganic nitrogen. Of the 80 lakes sampled, 56% had less mean chlorophyll a, and 51% had greater mean Secchi disc transparency.

Survey limnologists noted that this lake is very shallow and that heavy growths of rooted aquatic vegetation were observed. They also observed an algal bloom in progress in July, 1972.

B. Rate-Limiting Nutrient:

A loss of 990 µg/l of total phosphorus and 102 µg/l of inorganic nitrogen occurred in the assay sample from the time of collection to the time the assay was begun, and the results are unreliable.

The lake data indicate nitrogen limitation in July and September (N/P ratios were less than 10/1) but a borderline limitation in October (N/P ratio was 12/1).

C. Nutrient Controllability:

During the Survey year, it is estimated that the Village of Grey Eagle contributed about 88% of the total phosphorus load to Trace Lake. However, the Village is served by a stabilization pond, and the likelihood is that the pond does not overflow continually. If that is the case, the loading estimates probably are too high.

Further studies should be conducted on Trace Lake and the drainage to clearly define the effect of the nutrient contributions of the Grey Eagle wastewater treatment facility on the trophic condition of the lake.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry (no map available):

1. Surface area: 277* acres.
2. Mean depth: ?
3. Maximum depth: "very shallow"
4. Volume: ?
5. Mean hydraulic retention time: ?

B. Tributary and Outlet:
(See Appendix A for flow data)

1. Tributaries -

Name	Drainage area†	Mean flow†
None	-	-
Minor tributaries & immediate drainage -	1.2 mi^2	0.3 cfs
Totals	1.2 mi^2	0.3 cfs

2. Outlet -

Unnamed Stream	1.6 mi^{2}††	0.3 cfs

C. Precipitation†††:

1. Year of sampling: 28.9 inches.
2. Mean annual: 25.4 inches.

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* Anonymous, 1968.
† Drainage areas are accurate within ±5%; mean daily flows are accurate within ±10%; and ungaged flows are accurate within ±10 to 25% for drainage areas greater than 10 mi^2.
†† Includes area of lake.
††† See Working Paper No. 1, "Survey Methods".

III. LAKE WATER QUALITY SUMMARY

Trace Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, a near-surface sample for physical and chemical parameters was collected from a single station on the lake (see map, page vi). During each visit, a single sample was collected for phytoplankton identification and enumeration; and during the last visit, a single five-gallon sample was taken for algal assays. Also each time, a sample was collected for chlorophyll a analysis.

The results obtained are presented in full in Appendix B, and the data for the fall sampling period, when the lake was essentially well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

FALL VALUES

(10/24/72)

Parameter	Minimum	Mean	Median	Maximum
Temperature (Cent.)	-	(not done)		-
Dissolved oxygen (mg/l)	-	(not done)		-
Conductivity (μmhos)	420	420	420	420
pH (units)	8.1	8.1	8.1	8.1
Alkalinity (mg/l)	206	206	206	206
Total P (mg/l)	1.130	1.130	1.130	1.130
Dissolved P (mg/l)	0.088	0.088	0.088	0.088
NO_2 + NO_3 (mg/l)	0.360	0.360	0.360	0.360
Ammonia (mg/l)	0.720	0.720	0.720	0.720
		ALL VALUES		
Secchi disc (inches)	36	44	48	48

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera		Number per ml
07/06/72	1.	Anabaena	10,725
	2.	Dinobryon	1,594
	3.	Schroederia	254
	4.	Cocconeis	181
	5.	Cyclotella	181
		Other genera	72
		Total	13,007
09/02/72	1.	Anabaena	1,446
	2.	Dinobryon	542
	3.	Lyngbya	70
	4.	Microcystis	30
	5.	Synedra	10
		Other genera	-
		Total	2,098
10/24/72	1.	Dinobryon	2,075
	2.	Fragilaria	2,000
	3.	Flagellates	1,094
	4.	Anabaena	906
	5.	Cryptomonas	302
		Other genera	1,774
		Total	8,151

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
07/06/72	01	37.8
09/02/72	01	1.7
10/24/72	01	16.5

IV. NUTRIENT LOADINGS
(See Appendix C for data)

For the determination of nutrient loadings, the Minnesota National Guard collected monthly near-surface grab samples from the tributary site indicated on the map (page vi), except for the high runoff months of April and May when two samples were collected, and the colder months when ice cover and low flows prevented sampling. Sampling was begun in October, 1972, and was completed in September, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Minnesota District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for the outlet stream were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings. Nutrient loadings for "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated by using the nutrient loads, in lbs/mi^2/year, in Sucker Creek (tributary to nearby Pelican Lake) at station B-1 and multiplying by the ZZ area in mi^2.

The Village of Grey Eagle declined participation in the Survey, and nutrient loads were estimated at 2.5 lbs P and 7.5 lbs N/capita/year.

A. Waste Sources:

1. Known municipal -

Name	Pop. Served	Treatment	Mean Flow (mgd)	Receiving Water
Grey Eagle	325*	Pond	0.032**	Trace Lake

2. Known industrial - None

* Anonymous, 1973.
** Estimated at 100 gal/capita/day.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
None	-	-
b. Minor tributaries & immediate drainage (non-point load) -	70	7.6
c. Known municipal -		
Grey Eagle	810	88.0
d. Septic tanks - Unknown	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	40	4.3
Total	920	100.0

2. Outputs -

Lake outlet 200

3. Net annual P accumulation - 720 pounds

* See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/yr	% of total
a. Tributaries (non-point load) -		
None	-	-
b. Minor tributaries & immediate drainage (non-point load) -	1,750	25.5
c. Known municipal -		
Grey Eagle	2,440	35.6
d. Septic tanks - Unknown	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	2,670	38.9
Total	6,860	100.0

2. Outputs -

Lake outlet 1,720

3. Net annual N accumulation - 5,140 pounds

* See Working Paper No. 1.

V. LITERATURE REVIEWED

Anonymous, 1968. An inventory of Minnesota lakes. Bull. #25, MN Conservation Dept., St. Paul.

Anonymous, 1973. Wastewater disposal facilities inventory. MPCA, Minneapolis.

VII. APPENDICES

APPENDIX A

TRIBUTARY FLOW DATA

PRELIMINARY FLOW INFORMATION FOR MINNESOTA 10/30/74

LAKE CODE 2742 [illegible] LAKE

TOTAL DRAINAGE AREA OF LAKE 1.55

PRELIMINARY	UNCONTROLLED AREA	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
2742A1	1.55	0.09	0.11	0.13	0.08	0.09	0.06	0.03	0.34
2742J7	1.55	0.09	0.12	0.13	0.08	0.09	0.06	0.03	0.34

NORMALIZED FLOWS

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 1.55
SUM OF SUBDRAINAGE AREAS = 1.55

TOTAL FLOW IN = 4.09
TOTAL FLOW OUT = 4.07

MEAN PRELIMINARY FLOWS FOR DAILY FLOWS

PRELIMINARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2742A1	10	73	0.35	15	0.40				
	11	73	0.35	10	0.39				
	12	73	0.11	4	0.20				
	1	74	0.06	7	0.12				
	2	74	0.03	6	0.07				
	3	74	0.04	10	0.10				
	4	74	0.09	15	0.40	16	0.70		
	5	74	0.23	20	0.40	16	0.40		
	6	74	0.23	11	0.40				
	7	74	0.06	7	0.15				
	8	74	0.15	11	0.35				
	9	74	0.34	17	0.41				
2742J7	10	73	0.33	15	0.38				
	11	73	0.34	10	0.36				
	12	73	0.17	4	0.40				
	1	74	0.06	7	0.10				
	2	74	0.04	6	0.07				
	3	74	0.03	10	0.10				
	4	74	0.08	15	0.30	16	0.60		
	5	74	0.23	20	0.40	16	0.40		
	6	74	0.23	11	0.40				
	7	74	0.07	7	0.13				
	8	74	0.13	11	0.35				
	9	74	0.35						

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APPENDIX B

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 72/12/05

272201
45 44 52.0 093 49 44.0
TRACE LAKE
27 MINNESOTA

11 SITES
1 21111202
0005 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00403 PH	00410 T ALK CACO3 MG/L	00618 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/06	14 35	0.0	48	375	6.8	154	0.070	0.060	0.210	0.141
72/09/03	10 35	0.0	42	353	8.2	147	0.120	1.560	0.240	0.184
72/10/24	17 35	0.0	36	420	8.1	208	0.340	0.720	1.130	0.088

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLOROPHYL A UG/L
72/07/06	14 35	0.0	38.0
72/09/03	14 35	0.0	1.7
72/10/24	17 35	0.0	14.0

J VALUE KNOWN TO BE IN ERROR

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APPENDIX C

TRIBUTARY DATA

STORET RETRIEVAL DATE 74/10/30

2742A1 LS2792A1
45 50 30.0 094 45 30.0
UNNAMED STREAM
27 7.5 WARD SPRINGS
O/TRACE LAKE
AING UPSTREAM LADY LAKE 1.25 MI N GREY E
11SPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 N+NO2 TOTAL MG/L	00625 TOT KJEL TOTAL MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/11/15	11 45		1.350	1.700	0.315	0.024	0.053
72/11/19	12 10		0.670	1.600	0.060	0.030	0.058
73/03/10	09 40		2.600	2.310	0.620	0.065	0.154
73/04/19	09 45		0.110	1.470	0.042	0.024	0.057
73/04/30	10 50		0.350	1.470	0.044		0.132
73/05/20	10 50		0.066	2.200	0.072	0.064	0.135
73/05/30	10 50		0.055	1.600	0.040	0.060	0.375
73/06/11	11 30		0.140	1.500	0.069	0.095	0.375
73/07/17	09 45		0.340	4.200	0.750	0.380	1.150
73/08/11	09 40		0.550	2.700	0.590	0.048	0.430

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